

## **PART II**

# **ARIZONA WILLOW CONSERVATION ASSESSMENT**

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## I. INTRODUCTION

This conservation assessment presents the existing data available for Arizona willow in Arizona and Utah. The biology of the species, including its description, distribution, and habitat, are discussed within the current environmental setting. Land uses, habitat modification, and impacts from past and current threats are evaluated. Current protection mechanisms available to Arizona willow are reviewed.

While our understanding of the ecology, biology, and management needs of Arizona willow are insufficient to produce a conclusive assessment and strategy, this document has been developed using all available data and provides the initial direction for conservation until more information is available.

## II. NOMENCLATURE AND DESCRIPTION

A previously undescribed species of willow occurring in high elevation riparian areas in the vicinity of Mount Baldy, in the White Mountains of east-central Arizona, was first recognized as a distinct form by Granfelt in 1969 (Phillips *et al.* 1982). Dorn (1975) described these plants as a new species, *Salix arizonica*, commonly known as Arizona willow, a member of the willow family (Salicaceae).

Although described as shrubby by Dorn (1975), Arizona willow exhibits several growth forms, including scraggly shrub, rounded shrub, prostrate mat or single stem, and large hedge or thicket. Plants may occasionally reach a height of 3 meters (m) (10 feet) or be as short as 1 centimeter (cm) (0.5 inches), but more typically are less than 0.75 m (2 feet) (Galeano-Popp 1988) to approximately 1.3 m (4 feet) in height. The mature leaves are ovate (egg-shaped) to broadly elliptic or obovate, with a rounded or cordate (heart-shaped) base, and 1.5 to 2.4 times as long as wide. The leaves are 1-5 cm (0.5-2.5 inches) in length and 0.5-3 cm (0.2-1.5 inch) in width. The short-petiolate (petiole 3-7.5 mm [0.1-0.3 inch] long) leaf has gland-tipped, finely

serrate (toothed) margins (7-21 teeth or glands per cm). The midrib of the leaf tends to remain pubescent, while the rest of the upper surface of the mature leaf is slick and shiny, and usually glabrous (non-haired). The lower leaf surface is non-glaucous. Leaves on rapidly growing sucker shoots may be much larger but still maintain the mature leaf length to width ratio.

Pistillate (female) catkins are densely flowered, 1-4.5 cm (0.5-2 inch) long, with glabrous ovaries. The inflorescence has brown, black, or bicolor floral bracts 1-2.5 mm long, with wavy hairs and acute tips (Dorn 1975). The branches of the year are yellow-green, red-brown, or brownish in color and are pilose (densely haired). The branches from the previous years growth are usually bright red, and help to distinguish this species from other willow species in the area (Figure 3).

### III. DISTRIBUTION

As of March 1995, the distribution of Arizona willow is known to include four widely disjunct areas: the Mount Baldy vicinity of the White Mountains in east-central Arizona; and from south-central Utah, on the Markagunt Plateau in the vicinity of Brian Head Peak, the Paunsagunt Plateau along the East Fork of the Sevier River, and the Seven Mile Creek drainage on the Fishlake Plateau (Part I, Figure 1).

In Arizona, Arizona willow is known only from the vicinity of Mount Baldy, on Federal land managed by the Apache-Sitgreaves National Forests (Apache-Sitgreaves NFs) on the Springerville Ranger District, and on the Fort Apache Indian Reservation (Reservation). A small amount of Arizona willow habitat occurs on private land.

Intensive surveys conducted in Arizona on the Apache-Sitgreaves NFs (Galeano-Popp 1988) and Reservation (Granfelt 1989a) have found Arizona willow to occur in 15 to 20 drainages that generally flow to the north, east, or south from Mount Baldy. The species is found within very limited habitats at elevations above 2,600 m (8,500 feet) in Arizona within a geographic area of approximately 13.5 kilometers (8.5 miles) to the east and west, and approximately 22 kilometers (13.5 miles) to the north and south, a total range of approximately 300 square kilometers (km) (115 square miles) (Galeano-Popp 1988).

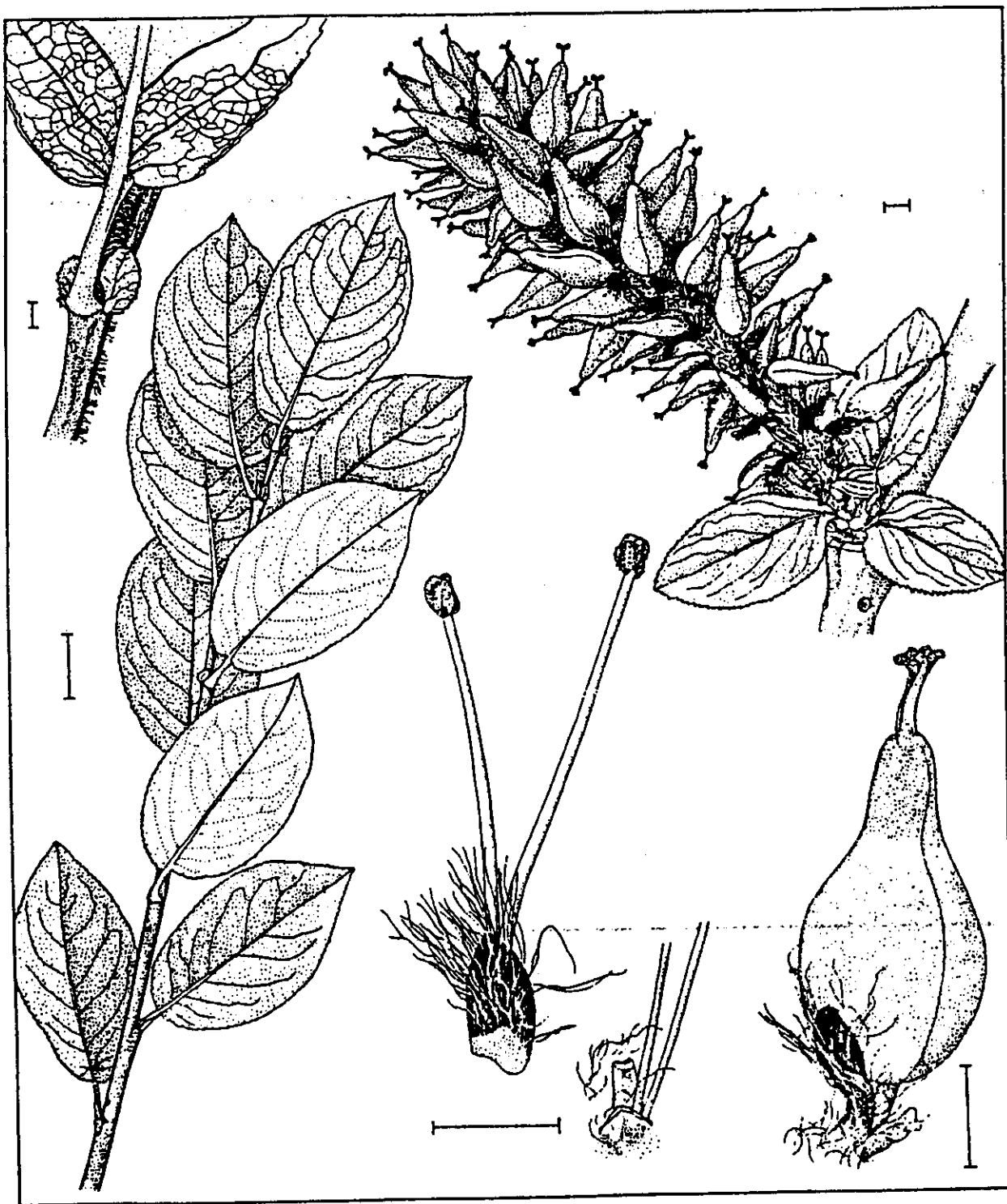


Figure 3. Arizona willow (*Salix arizonica*) morphological characteristics. From G. Argus, Canadian Museum of Nature, Ottawa, Ontario, Canada, with permission. The scale bars shown are as follows: upper left 1 mm; upper right 1 mm; center left 1 cm; bottom center 1 mm; bottom right 1 mm.

Dorn (1975) conducted extensive field work in much of western North America and examined thousands of herbarium specimens as part of his taxonomic revision of the section *Cordates* of the genus *Salix* (willow species) in North America. Surveys and status assessments for Arizona willow have been conducted in the vicinity of the White Mountains by Fletcher (1978), Phillips *et al.* (1982), Galeano-Popp (1988), and Granfelt (1989a and 1989b). Galeano-Popp (1988) and Granfelt (1989b) specifically surveyed for Arizona willow outside of its known range within the White Mountains complex. Additionally, Argus (*in litt.* 1991), while investigating the taxonomic relationship between *S. arizonica* and *S. boothii*, examined numerous specimens of these easily confused species. As part of these investigations by Argus and Dorn, an herbarium specimen collected in 1913 from Utah and incorrectly identified as black willow (*S. pseudomyrsinites* Andersson), was annotated by Dorn as *S. arizonica*.

In June of 1993, the U.S. Fish and Wildlife Service (FWS) was notified about the previously misidentified specimen of Arizona willow collected in 1913 from high elevation habitats of the then named "Sevier Forest" in southern Utah (Argus *in litt.* 1993). The Sevier Forest is now included in the Dixie National Forest (Dixie NF). Though the specimen collection data was incomplete, preliminary surveys were conducted in Utah during the summer of 1993 by FWS. No Arizona willow were found (England pers. comm. 1993). After notification of the early Utah collection, the USDA Forest Service (FS) initiated surveys in June of 1994 resulting in the "rediscovery" of Arizona willow on Cedar Mountain, Cedar City Ranger District, Dixie NF on June 30, 1994 (Rodriguez *et al.* 1995). Subsequent surveys during the summer and fall of 1994 documented additional Arizona willow populations on the Cedar City and Powell Ranger Districts of the Dixie NF, on the Loa Ranger District of the Fishlake National Forest (Fishlake NF), on Cedar Breaks National Monument, and adjacent private land. Dorn confirmed the identity of the Utah populations as Arizona willow as part of field investigations in August of 1994 (Rodriguez *et al.* 1995) (Appendix D). These populations of Arizona willow discovered in Utah during the 1994 field season add significant "new data" on the species distribution and status.

Based on three months of survey data in Utah, Arizona willow has been documented from three general locations. The largest populations (10) are found on the Markagunt Plateau in the

vicinity of Brian Head Peak, within the Dixie NF, Cedar Breaks National Monument, and private land. This geographic area is approximately 24 km (15 miles) in diameter. The second location includes one very small population located on the Paunsagunt Plateau within the watershed of the East Fork of the Sevier River on the Dixie NF. The third area is on the Fishlake Plateau within the Seven Mile Creek drainage on the Fishlake NF, approximately 170 km (105 air miles) northeast of Brian Head Peak. The population located within the Seven Mile drainage was mapped through one week of field survey work during 1994. Arizona willow has been found in Utah at elevations ranging from 2,550 m to 3,290 m (8,360 to 10,800 feet).

Though the Arizona willow surveys conducted in Utah during 1994 added substantial information to our knowledge on the distribution of the species, additional potential habitat occurs on the Dixie and Fishlake NFs. More surveys are scheduled for 1995. Also, potential habitat may occur in other National Forests in southern Utah, as well as in western Colorado and northern New Mexico. In Arizona the appropriate high elevation wet meadow or stream side habitats required by Arizona willow are very limited outside of the White Mountains. Other potential sites for Arizona willow in Arizona would include the inner basin of the San Francisco Peaks in the vicinity of Flagstaff, on the Coconino National Forest.

#### IV. HABITAT AND ECOLOGY

Arizona willow requires a specific habitat of limited occurrence. Arizona willow habitat usually occurs as a narrow linear strip, in unshaded or partially shaded wet meadows, along streamsides, in cienegas, and typically in or adjacent to perennial water. It often occurs in saturated soils but attains its greatest stature on soils which are moist but not entirely saturated (Granfelt 1989a, Subirge 1993, Medina *in litt.* 1993). Less commonly, plants are found at seeps and springs, in meadows adjacent to forest edges or in meadows with sparse stands of spruce. Plants are also found in drier sites within the riparian zone (Galeano-Popp 1988, Granfelt 1989a). In these drier sites, there is some evidence that subsurface stream channels exist, suggesting that plants had established along flowing streams (Galeano-Popp 1988, Granfelt 1989a, Subirge 1993). All but one Arizona willow site occurs on basaltic (volcanic) soils. In Utah, there is one population found on soils derived from Wasatch limestone (Rodriguez *et al.* 1995). Arizona willow can be found in extremely rocky situations, though this is considered uncommon (Galeano-Popp

1988). Plants have been found occupying all aspects, but they primarily trend east, north, or south, on sites with less than nine percent slope (Rodriguez *et al.* 1995). The habitat requirements for germination and seedling establishment may be different than that required by juvenile or established plants. Preliminary data by Subirge (1993) and Nelson (pers. comm. 1994) suggest that the occurrence of Arizona willow is, in part, determined by a relationship between soil moisture, texture, and aeration.

The factors responsible for the variations in growth habit of Arizona willow are not completely understood. Taller plants tend to occur in relatively protected sites, such as within the crowns of other woody vegetation (Galeano-Popp 1988, Medina *in litt.* 1989), are rooted in oxygenated sediments of fine gravels and coarse sand (Medina *in litt.* 1993), and the water table does not extend over the surface of the soil and may be as deep as 0.5-1.0 m (to 3 feet) within the soil (Subirge 1993). Prostrate forms, either as mats or single stemmed plants, may be an adaptive response to environmental factors and are often associated with high elevation cienegas where there is deep winter snowpack (Fletcher in Galeano-Popp 1988), late spring freezes (Medina *in litt.* 1989), and water saturated soils where subsurface anaerobic conditions may be very close to the surface (Medina *in litt.* 1993, Subirge 1993). Physical factors such as browsing may also influence plant stature and growth form (Galeano-Popp 1988).

Arizona willow blooms in early spring with male and female catkins produced on separate plants. The timing of budding, flower emergence, and leaf growth is dependant on the elevation and local climatic factors. Arizona willow may flower in late May to early July, with fruit maturing June through August, as the leaves reach full development. The seeds are extremely light-weight and are disseminated by wind and water. The time period in which Arizona willow seeds are capable of germinating may be quite brief (Medina *in litt.* 1992), but the seeds of Arizona willow have been found to germinate readily when provided ample moisture and light (Maschinski pers. comm. 1993). Galeano-Popp (1988) observed plants as short as 30 cm (12 inches) which produced some catkins. Arizona willow also reproduces vegetatively, which can confound enumeration of individuals. Distinguishing the stems of one clone from the stems of another clone can be difficult or impossible (Galeano-Popp 1988).

Arizona willow is known to introgress with other associated species. According to Dorn (pers. comm. 1994), willow (*Salix*) introgression and hybridization occurs among various species throughout North America, but is not a significant issue in determining willow taxonomy. The variation due to environmental gradients has a greater influence on morphologic variation within and among taxa (Atwood pers. comm. 1995).

Introgressed forms have been observed in Utah that occur with Arizona willow and *S. brachycarpa* at the CCC Camp population, with *S. boothii* at the Seven Mile population, and apparently with *S. wolfii* at Seven Mile on the Fishlake NF. These introgressed forms are few in comparison to total population numbers (Atwood pers. comm. 1995). Introgressed forms express a mix of morphologic features from both parents, but appear to be sterile since no viable seeds were produced, based on observations made in 1994 (Atwood pers. comm. 1995). In Arizona, if introgression occurs it probably would be between Arizona willow and *S. boothii* or *S. monticola*. A few individuals willow plants have been noted by Granfelt (*in litt.* 1995a) which have been difficult to identify morphologically.

In Arizona, Arizona willow densities are extremely variable. Within the riparian corridor, Arizona willow plants may be clustered, individuals may occur singly or be widely spaced (more than 2 km or 1 mile apart) (Galeano-Popp 1988), may form open linear stands along streams for reaches up to 2 km (1 mile) in length (Granfelt *in litt.* 1992), or may be the dominant shrub in large, dense patches, occupying more than 100 hectares (ha) (up to several hundred acres) (Rodriguez *et al.* 1995). The presence and quantification of Arizona willow is often concealed by dense grasses and sedges (Granfelt 1989a).

Galeano-Popp (1988) recorded 15 populations of Arizona willow on the Apache-Sitgreaves NFs. Of these populations, eleven had extremely low densities, and nine of these had fewer than five plants per 1 km (0.6 mile) of stream reach. Approximately 50 percent of all known plants on the Forest are within a 3.2 km (2 mile) reach of the West Fork of the Little Colorado River in the Mount Baldy Wilderness Area, and approximately 40 percent of all Forest plants are within a 4 km (2.5 mile) reach of the East Fork of the Little Colorado River, from upstream of the Phelps Cabin Botanical Area to Colter Reservoir. Subsequent to Galeano-Popp's 1988 surveys, additional plants have been located on the Forest within known populations and one or two new



sites have been found, each with very low plant densities (Subirge pers. comm. 1992, and Medina *in litt.* 1989).

Granfelt documented at least 26 distinct sites with Arizona willow on the Reservation (Granfelt 1989a, *in litt.* 1995a). Populations at Smith, Skeeter and Purcell Cienegas may each exceed 1,000 individuals, though most of the plants at Smith and Purcell Cienegas are prostrate, non-flowering, single-stemmed forms. The most vigorous populations on the Reservation are reported from Reservation Creek and Skeeter Cienega, each with plants exceeding 0.75 m (2 feet) in height and with both male and female plants producing catkins. Several other populations on the Reservation have many individuals. Eight sites on the Reservation are considered to be low density, with less than 30 plants each (Granfelt *in litt.* 1991).

Galeano-Popp (pers. comm. 1991) and Granfelt (1989a and *in litt.* 1992) believe that all major habitat sites in the White Mountain region of Arizona have been surveyed and that no significant populations of Arizona willow remain to be found there. Additional surveys may locate isolated plants that were not located during previous surveys. As habitat conditions improve through improved management efforts, additional surveys should be initiated to locate individuals and populations that may have surfaced through release of grazing induced stress (Atwood pers. comm. 1995). The majority of all known Arizona willow plants and approximately 80 percent of all currently occupied Arizona willow habitat in Arizona are on the Reservation.

Although there are no historic records documenting the former distribution of Arizona willow, Galeano-Popp (1988) and Granfelt (1989a) both determined, based upon known occurrences of Arizona willow, its scattered distribution, and the assessment of appropriate habitat, that unoccupied habitat within the known range does exist. Galeano-Popp (1988) also speculated that Arizona willow may have occurred historically in the Burro Creek, Big Lake, and Crescent Lake areas, and possibly in the upper portion of Hayground Creek.

Eighteen Arizona willow sites occur on the Markagunt Plateau, on and adjacent to the Dixie NF in Utah. These occur in high elevation wetland habitats generally similar to those in Arizona. Various growth forms are manifest based on soils, moisture, and herbivore impacts. However, in coarse, well drained soils on the Markagunt Plateau, individual plants are often robust shrubs

1.3 m (4 feet) tall, forming large, dense patches, sometimes occupying more than 100 ha (several hundred acres). In many areas, Arizona willow is often the dominant shrub component. Eleven populations are estimated to include from thousands to tens-of-thousands of plants each. The other nine populations on the Markagunt Plateau have less than 200 plants each. Individuals are seldom found to be widely spaced throughout a drainage. The largest populations, Rainbow Meadows, Lowder Creek, and Powerline, occupy 123 ha (304 acres), 57 ha (142 acres), and 42 ha (105 acres), respectively. These three populations dominate their respective willow communities. There are approximately 354 ha (874 acres) of occupied Arizona willow habitat on the Markagunt Plateau, of which 85 ha (210 acres) occur on private land (Rodriguez *et al.* 1995).

One population with a single site is known from the Paunsagunt Plateau along the East Fork of the Sevier River. This population contains 14 individuals.

On the Fishlake NF, the known range of Arizona willow is limited to the Seven Mile Creek drainage as based on surveys conducted in 1994. This population has been surveyed for approximately four miles along the stream and adjacent meadows and riparian stringers, and occupies 61 ha (151 acres). Arizona willow has been located within the entire length of the area surveyed in elevations ranging from 2,800 m to 2,865 m (9,200 to 9,400 feet). Plants were most commonly located adjacent to perennial streams, but were also associated with numerous springs and seeps. It was not uncommon to find Arizona willow adjacent to forested edges. Some plants were located in drier upland sites along forested edges. Arizona willow tends to occur in large, dense patches, sometimes occupying up to 12 ha (30 acres) in size. Individuals were generally clustered, but occasionally occurred as single individuals spaced throughout a drainage mixed with various other willow species (Rodriguez *et al.* 1995).

Transplant efforts for Arizona willow were undertaken by the Apache-Sitgreaves NFs to assess the feasibility of propagating Arizona willow cuttings in a nursery for the purpose of producing containerized plants for reintroduction to potential sites. Arizona willow cuttings were collected, grown for two years, and three-hundred plants were transplanted near Merlin Reservoir and on the east side of Burro Mountain. Within several years, all but a few individuals from these

plantings have died, attributed primarily to elk browsing and extremely dry conditions. However, these efforts have helped provide insight into the assessment of appropriate habitat.

Arizona willow is part of a high elevation riparian community which occurs along streambanks and in wet meadows within the subalpine conifer forests of Engelmann spruce (*Picea engelmannii*), blue spruce (*Picea pungens*), Douglas-fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), subalpine fir/corkbark fir (*Abies lasiocarpa*) and quaking aspen (*Populus tremuloides*). In Arizona, Arizona willow grows in riparian communities which may include any of several other willow species, such as: serviceberry willow (*Salix monticola*), Geyer willow (*S. geyeriana*), Bebb willow (*S. bebbiana*), plainleaf willow (*S. planifolia*), and occasionally Booth's willow (*S. boothii*) and blue-stem willow (*S. irrorata*). Some of the plant species also associated with Arizona willow in Arizona include: shrubby cinquefoil (*Potentilla fruticosa*), varileaf cinquefoil (*Potentilla diversifolia*), monkeyflower (*Mimulus primuloides* and *M. guttatus*), trumpet gooseberry (*Ribes leptanthum*), buttercups (*Ranunculus aquatilis*, *R. macounii*, and *R. cymbalaria*), wild onions (*Allium geyeri*, *A. rubrum*, and *A. macropetalum*), violet (*Viola adunca*), marsh marigold (*Caltha leptosepala*), bitter cress (*Cardamine cordifolia*), shooting star (*Dodecatheon alpinum*), willow weed (*Epilobium* spp.), Bigelow groundsel (*Senecio bigelovii*), tufted hairgrass (*Deschampsia caespitosa*), meadow barley (*Hordeum brachyantherum*), alpine Timothy (*Phleum alpinum*), fescues (*Festuca* spp.), sedges (*Carex* spp.), rushes (*Juncus* spp.), and moss (*Aulacomnium palustre* and *Climacium dendroides*) (Galeano-Popp 1988, Subirge 1993, Granfelt *in litt.* 1995a). Throughout much of Arizona willow habitat on the Apache-Sitgreaves NFs, the nonnative grass species Kentucky bluegrass (*Poa pratensis*) forms dense sod within the riparian corridor (Subirge 1993). On the Reservation, dense Kentucky bluegrass sod is typically located at elevations lower than is normal for Arizona willow (Granfelt *in litt.* 1995a).

In southern Utah, the riparian communities with Arizona willow include some plant species not found in Arizona, but it also includes various species of willows such as barren-ground willow (*Salix brachycarpa*), coyote willow (*S. exigua*), Geyer willow (*S. geyeriana*), Wolf willow (*S. wolffii*), Booth's willow (*S. boothii*), and plainleaf willow (*S. planifolia*). Other species associated with Arizona willow in Utah include western yarrow (*Achillea millefolium*), American

bistort (*Polygonum bistortoides*), mountain deathcamas (*Zigadenus elegans*), elkslip marshmarigold (*Caltha leptosepala*), elephant lousewort (*Pedicularis groenlandica*), largeleaf avens (*Geum macrophyllum*), meadow barley (*Hordeum brachyantherum*), alpine timothy (*Phleum alpinum*), common dandelion (*Taraxacum officinale*), smallwing sedge (*Carex microptera*), beaked sedge (*Carex rostrata*), water sedge (*Carex aquatilis*), Nebraska sedge (*Carex nebraskensis*), golden sedge (*Carex aurea*), small-leaf angelica (*Angelica pinnata*), Kentucky bluegrass (*Poa pratensis*), Columbia monkshood (*Acontium columbianum*), wanderer violet (*Viola nephrophylla*), shrubby cinquefoil (*Potentilla fruticosa*), varileaf cinquefoil (*P. diversifolia*), tall larkspur (*Delphinium occidentale*), tufted hair-grass (*Deschampsia caespitosa*), western wheatgrass (*Agropyron smithii*), and Baltic rush (*Juncus balticus*) (Mead and Rodriguez 1994).

The high elevation riparian ecosystem upon which Arizona willow depends is fragile and also provides habitat for other rare species of plants and animals. In Arizona such species as Mogollon paintbrush (*Castilleja mogollonica*), Gila groundsel (*Senecio quaerens*), Mogollon clover (*Trifolium longipes* var. *neurophyllum*), Goodding onion (*Allium gooddingii*), New Mexico jumping mouse (*Zapus hudsonius luteus*), and the threatened Apache trout (*Oncorhynchus apache*) occur in the same ecosystem as Arizona willow. In Utah, rare species such as paradox bloodmoonwort (*Botrycium paradoxum*), Navajo Lake milkvetch (*Astragalus limnocharis* var. *limnocharis*), boreal toad (*Bufo boreas*) and willow flycatcher (*Empidonax traillii*) are found within Arizona willow ecosystems.

These habitats have been subjected to numerous uses for more than a century which have degraded habitat conditions, brought about changes in local riparian community species composition, and have altered the natural hydrological characteristics of many stream systems. The rarity and scattered distribution of Arizona willow indicate the species may have once been more common. In addition, the limited evidence of successful Arizona willow seedling establishment, the presence of a possibly virulent pathogen, and the comparison of Arizona and Utah populations, suggest many of the natural functions of these high elevation riparian ecosystems have been disrupted.

Studies on the distribution, biology, autecology, habitat, and ecology of Arizona willow continues, with several investigations in progress in Arizona (Medina 1991, Subirge 1993) and in Utah (Mead and Harper 1994, Taylor and Harper 1994, Rodriguez 1994, Van Buren and Harper 1995). McArthur (1995) is currently completing chemical analysis of Arizona willow populations from Arizona and Utah using thin layer chromatography.

## V. THREATS, LAND USE, AND HABITAT MODIFICATION

The ecological processes which effect Arizona willow and its habitat are very complex and interconnected, involving not only the riparian zone but the entire watershed. These natural processes are poorly understood, as are the specific ecological factors which have restricted successful Arizona willow propagation and consequently have contributed to habitat degradation for this species. All Arizona willow habitat in Arizona may be considered as degraded today in comparison to what once existed (Granfelt *in litt.* 1992).

Populations of Arizona willow may be limited by a variety of factors. Habitat fragmentation in Arizona has resulted in small, isolated populations, often with so few plants remaining (even as low as one) that the populations may no longer be viable and are easily impacted by any natural or man caused action (Granfelt *in litt.* 1991). Sexual reproduction within small populations depends on the relative proportion of male and female plants and their proximity to plants of the opposite sex. In addition, competition with other less palatable species of willow and exotic species (e.g., *Poa pratensis*) may have contributed to the decline of Arizona-willow populations (Medina *in litt.* 1989).

Populations in Utah are often dominated by Arizona willow in association with plainleaf willow. Plants are often robust uniform stands, 1.3 m (4 feet) tall forming large, dense patches. Of all Arizona willow populations known, the populations on the Markagunt Plateau are the largest, most dense stands known. These populations are primarily in mid to late seral stages but represent healthy vigorous stands that produce large amounts of flowers and fruit. Granfelt (pers. comm. 1994) called these Utah populations the "mother lode."

## A. Disruption of Hydrologic Processes

The stream hydrology and sediment transport characteristics of these high elevation systems have many ramifications to Arizona willow. Cattle, elk, rodents, and human recreational use each contribute to bank instability. Bank collapse due to cattle movements and concentrated use in riparian areas was reported by Galeano-Popp (1988) and Rodriguez (1994) as common and widespread within Arizona willow habitat on Forest lands. Medina (*in litt.* 1989) reported that in Arizona, elk (*Cervus elaphus*) may also effect bank stability, and that tunneling by rodents weakens stream bank integrity, especially due to the prevalence of shallow rooted Kentucky bluegrass rather than the more deeply rooted native riparian species. Elk in Utah, however, are of relatively lower densities and are not known to have contributed to stream bank instability.

Erosion and siltation may adversely affect Arizona willow through the accumulation of fine textured deposits and its effect on soil aeration characteristics and depth of the water table. Dense mats of Kentucky bluegrass and sedges act as a filter within the riparian zone, both trapping sediments and increasing flow resistance which allows deposition of fine materials to occur (Subirge 1993). The decay of the fine textured root mass of Kentucky bluegrass and sedges further contributes fine organic sediments to the stream system (Subirge 1993). These conditions may also effect the meander pattern of the stream (Subirge 1993). In many areas of Arizona willow habitat on the Apache-Sitgreaves NFs, 30-45 cm (12-18 inches) of silt sediments has accumulated, heavily loaded with organic deposits. These sediments include particulates dislodged by grazing ungulates and from decaying vegetation. The fine sediments impair the vertical diffusion of gasses within the soil profile and provide substrate for bacteria which further contribute to anaerobic conditions (Subirge 1993). These sediment deposits alter habitat conditions for Arizona willow and may contribute to low recruitment and reduced plant vigor. Galeano-Popp (1988) observed vigorous seedlings on the Apache-Sitgreaves NFs on only a few occasions. Working in Arizona on the Apache-Sitgreaves NFs and Reservation, Medina (*in litt.* 1993) reported seedlings were rarely encountered and that Arizona willow population age structure appeared heavily skewed toward older, non-healthy plants.

Few seedlings were encountered in Utah; however, these populations consisted of healthy vigorous stands that produced large amounts of flowers and fruits. Within the Crystal Springs,

East Powerline, Hancock Peak, Lowder Creek, Midway Face, Powerline, and Rainbow Meadows populations, virtually all potential habitat appears to be occupied by Arizona willow and other willow species.

The Cedar Breaks National Monument portion of the CCC Camp population consists of healthy, vigorous, low growing plants in comparison to those on adjacent Dixie NF. A distinct fence line contrasts demonstrates impacts from excessive livestock use on the Forest (Rodriguez *et al.* 1995).

The Apache-Sitgreaves NFs has been working to address the problem of sedimentation from roadways near riparian crossings. These roads have been sprayed with oils or a surface sealant to bind soil particles together to prevent sediments from entering the stream system.

The construction of high elevation lakes, reservoirs, and ponds has resulted in the permanent loss of Arizona willow populations and habitat in Arizona. These impoundments were constructed for recreational fishing, and/or livestock and wildlife waters. In Arizona, the presence of Arizona willow along Reservation Creek both above and below Reservation Lake and its minor tributaries provide convincing evidence that Reservation Cienega, prior to inundation and creation of Reservation Lake, supported an Arizona willow population. Similar evidence of inundated Arizona willow populations is found above and below Hurricane Lake, Colter Reservoir and Lee Valley Reservoir. The construction of Sunrise Lake, White Mountain Reservoir, and several minor impoundments, inundated Arizona willow habitat (Galeano-Popp 1988, Granfelt 1989a and *in litt.* 1991). However, these impoundments were constructed before the description of Arizona willow as a new species or prior to the knowledge of the limited distribution of this species. Though these dams were constructed years ago, they continue to effect stream hydrology and alter the natural flood regime. Organic residues accumulate within and below reservoirs where stream flow energy is now insufficient to flush out deposits. The stream below Lee Valley Reservoir is silting in and not maintaining a defined channel with its associated stream-side habitats (Subirge 1993).

The presence of these reservoirs may also contribute to increased wildlife use within Arizona willow habitats (Galeano-Popp 1988). Arizona willow populations occur at sites which may be

considered as prime locations for construction of future reservoirs. However, neither the Apache-Sitgreaves NFs, White Mountain Apache Tribe (Tribe), nor Arizona Game and Fish Department (AGFD) has indicated there are any plans for new reservoirs in the Mount Baldy area of Arizona. In Utah, there are no plans for new reservoirs in the Brian Head, East Fork of the Sevier River, or Seven Mile Creek areas.

On the Reservation, a water diversion ditch and pipeline were constructed in the late 1970s to transfer water from Becker Creek, across a tributary of Snake Creek, to Sunrise Lake to maintain water levels and improve water quality in the lake. This diversion was considered to have affected the flow regime of the tributary to Snake Creek where a population of Arizona willow occurs (Fairweather 1993). However, near normal stream flows appear to occur within this intermittent drainage following snow melt and summer thunder showers (Granfelt *in litt.* 1995b). The robust Arizona willow population along this stream was infected by a rust pathogen in 1988 and severely impacted (Granfelt 1989a). The factor(s) that caused Arizona willow mortality within this stand following the rust infestation has not been established.

#### B. Livestock and Wildlife

Arizona willow is exposed to herbivory from numerous species of vertebrate and invertebrate animals, including cattle (Galeano-Popp 1988, Granfelt 1989a), elk (Galeano-Popp 1988, Granfelt 1989a, Medina *in litt.* 1989), deer (Rodriguez *et al.* 1995), voles (Medina *in litt.* 1989), beetles (Medina *in litt.* 1993), and the caterpillars of butterflies (Subirge pers. comm. 1992, Fairweather 1993). Herbivory results in the loss of plant material which may reduce plant vigor and reproductive success, decrease plant height, and affect plant growth habit.

Historic livestock grazing in high elevation riparian communities has been extensive and has caused major impacts contributing to Arizona willow habitat degradation. Heavy stocking rates were present throughout the East Fork of the Sevier River and Seven Mile areas from about 1870 to present day (Atwood and Rodriguez 1994). Livestock use was especially high in the Mount Baldy vicinity of the White Mountains during the 1910-1940 period (Granfelt *in litt.* 1992). Livestock grazing has brought about many impacts, including changes in species composition especially to the riparian vegetation community, but also to the upland vegetative



communities. The introduction of nonnative species, and the alteration of stream hydrology has had a significant impact in the degradation of riparian plant communities.

Livestock grazing in Arizona willow habitat continues to present day. On the Apache-Sitgreaves NFs, most Arizona willow habitat is included within five grazing allotments. On the Reservation, little cattle grazing has occurred during the past twenty to thirty years in the high elevation areas of Mount Baldy (Granfelt *in litt.* 1992). However, there are several active livestock grazing areas on the Reservation within Arizona willow habitat, including the general vicinity of Reservation Lake and a tributary of Snake Creek. Within the areas on the Reservation where there has been little recent livestock use, the plant communities have been developing without the impact of domestic livestock. The existing Arizona willow populations are being maintained, but it is not evident that the habitat has improved for its expansion. The specific requirements for such expansion are not known (Granfelt *in litt.* 1992).

In Utah, Arizona willow habitat is included in eight grazing allotments. On the Dixie NF, four of seven allotments are permitted for sheep grazing. The remaining 4 allotments, three on the Dixie NF and one on the Fishlake NF, are permitted to cattle. Historical sheep use on the Dixie NF was once more extensive than current permitted numbers. Sheep use on the Dixie NF has primarily been observed in the uplands, above the riparian areas. Therefore, sheep grazing has not been identified as a primary concern to the viability of Arizona willow populations in Utah. Within some Arizona willow populations, livestock have contributed to habitat degradation, to a reduction in the health and vigor of Arizona willow, and probably to the loss of individual plants and/or clones (Rodriguez *et al.* 1995). However, most Arizona willow populations are healthy, vigorous stands that produce large amounts of flowers and fruits. The Cedar Mountain population located on the Cedar City Ranger District, Dixie NF, contains healthy viable populations. The East Fork of the Sevier River population's viability is questionable due to the lack of reproducing individuals, very low population number (14 individuals), and significant habitat loss as a result of hydrologic changes and livestock grazing. The CCC Camp populations occurs along the eastern boundary of Cedar Breaks National Monument with Dixie NF. The boundary fence provides an artificial L-shaped enclosure which the local sheepherder on the Forest uses as a holding-bedding ground. Over the years this has had a significant impact on the vegetation in the area. A distinct fence line contrast exists between the Monument and

the Forest. Arizona willow plants on the Monument are very healthy, dense stands, in contrast to the few plants and poor condition on the Forest portion. Populations within the Seven Mile drainage appear to be viable; however, overall Arizona willow stand and ecosystem health is low, evidenced by poor plant vigor and very little annual leader growth or catkin development.

Neither the riparian nor the upland communities in the Seven Mile drainage are in, or are progressing toward, the desired condition. The allotment management plan developed in 1986 was not fully implemented, and the Seven Mile Creek watershed remains in degraded condition.

In Arizona, the most pervasive effect of past and current livestock use in Arizona willow habitat on the Apache-Sitgreaves NFs is the persistence and dominance of the nonnative Kentucky bluegrass along streamsides and in wet meadows. This grass often forms a dense, shallow rooted sod in riparian areas, particularly when exposed to heavy grazing pressure (Subirge 1993). The presence of Kentucky bluegrass directly effects Arizona willow by the rapid colonization of exposed soils and the formation of thick sod. Kentucky bluegrass prevents Arizona willow seeds from reaching bare soils and germinating, and decreases the nutrients available for establishment of Arizona willow plants (Subirge 1993). In Utah, Kentucky blue grass is a minor component of riparian vegetation in Arizona willow habitat and does not appear to be a significant factor affecting Arizona willow seedling establishment.

Arizona willow is palatable to cattle and elk, and is readily consumed by both species (Galeano-Popp 1988, Medina *in litt.* 1989). Whether cattle or elk preferentially select Arizona willow (Galeano-Popp 1988) or consume it incidental to the grazing of adjacent vegetation (Medina *in litt.* 1993) is uncertain, as is the proportion of the total use on Arizona willow to be attributed to either herbivore species. However, the effects of grazing on Arizona willow, by what ever species, are additive. In Arizona, taller Arizona willow plants typically occur in relatively protected sites, such as within the shelter of larger willows species (Galeano-Popp 1988, Medina *in litt.* 1989) or at exposed rocks along streams where access by herbivores is restricted (Fairweather 1993).

To examine the effects of livestock grazing on Arizona willow on the Apache-Sitgreaves NFs, Galeano-Popp (1988) compared the heights of plants occurring within and outside the livestock grazing exclosure around the Phelps Botanical Area. The tallest Arizona willow plants on the

Forest known at that time were within the enclosure, where the weighted mean plant height was 25 cm (10 inches) taller than immediately outside the enclosure. Further comparisons by Galeano-Popp (1988) found significantly lower plant densities in the livestock grazed sites versus the ungrazed sites. The prevalence of low density sites on the Forest, in contrast to Reservation populations where livestock grazing is limited, provides additional evidence that livestock grazing has contributed to a reduction in plant density and distribution on the Forest (Galeano-Popp 1988).

Galeano-Popp (1988) reported that two Arizona willow sites on the Apache-Sitgreaves NFs were under immediate threat of loss due to over-utilization, primarily by livestock. Granfelt (1989a) reported that one population on the Reservation was in jeopardy due to elk and livestock grazing pressures. Grazing impacts may be responsible, in part, for the prevalence of short stature, non-flowering plants throughout the range of Arizona willow (Galeano-Popp 1988).

Livestock and elk can physically damage Arizona willow by trampling plants. Hoof action can break stems, especially of low growing forms, and sever roots causing die back (Medina *in litt.* 1993). No data are available to quantify the degree of physical damage by elk and livestock to Arizona willow.

Populations of Arizona willow in Utah show selective grazing, primarily by cattle. In Lowder Creek, it was evident that selected Arizona willow plants were grazed by cattle and showed heavy use in comparison to other plants in the area that were ungrazed. Within the Sheep Herder site, selected plants were grazed by domestic sheep and possibly by a horse that was hobbled in the area by the permittee.

The Arizona willow population at the East Fork of the Sevier may have been impacted by historical cattle grazing. This population consists of 14 robust plants; however, catkin and seed production was observed to be limited in 1994. No seedling recruitment was observed within this riparian community (Rodriguez *et al.* 1995). Potential habitat was surveyed above this population with negative results. This population is the only known population found on sedimentary soils; all other populations in Utah and Arizona occur on volcanic soils. Due to the uniqueness of this population, a detailed soils analysis, and chemical analysis of the species

(chromatography), has been initiated as a part of a Brigham Young University (BYU) graduate research program and FS Intermountain Research Station investigations. Recognizing the importance of this population, 10 of the 14 plants have been fenced with a 3-way experimental exclosure.

Elk are generalists herbivores, feeding on grasses and shrubs (Murie 1951, Boyce 1989). Elk utilize willows at all seasons of the year, favoring the youngest shoots (Murie 1951, Despain 1989). Elk use of Arizona willow is evident on both the Apache-Sitgreaves NFs and Reservation (Granfelt 1989a, Medina *in litt.* 1989). Elk numbers have been reduced on the Apache-Sitgreaves NFs over the last several years in order to meet established population herd objectives as stated in the approved AGFD elk management plan (see Part IV, D). Granfelt (1989a) found that Arizona willow utilization by elk was common at almost all sites on the Reservation. The impact of elk use on Arizona willow is reflected in lower plant stature and a hedged appearance. On the Reservation, Arizona willow plants have been closely browsed along Ord Creek at Smith Cienega, an elk concentration area. The direct effects of grazing on Arizona willow are present throughout the range of the species but are manifest to a much greater degree in areas where both elk and livestock are present (Galeano-Popp 1988).

Elk numbers on the Dixie and Fishlake NFs are significantly lower than those found in the White Mountains of Arizona. Elk numbers are in stable condition, all of which are within established population herd objectives, as stated in approved elk management plans. Field data from Utah indicate that elk use on Arizona willow plants is negligible. Preliminary data collected by research graduate students, and field observations by agency personnel indicated that little wildlife grazing occurs on Arizona willow (Rodriguez *et al.* 1995). To quantify this, four three-way experimental exclosures have been established to collect baseline data of ungulate use on Arizona willow and associated species. These have been established on Lowder Creek, Sheep Herder, and East Fork of the Sevier sites on the Dixie NF and will be in place on Seven Mile Creek on the Fishlake NF in summer 1995 (Taylor and Harper 1994).

Deer numbers are down throughout the State of Utah and observations of use on willow has not been documented. Deer observations in the East Fork of the Sevier population has not been recorded; however, this population of deer is slightly higher than other populations in Utah

within Arizona willow habitat. Herbivory from deer is likely occurring; however, not on a measurable level.

Moose (*Alces alces*) occur within the Seven Mile drainage on the Fishlake NF. Direct effects of grazing on Arizona willow is unknown; however, no noticeable use was observed during field observations in 1994. Monitoring will be an ongoing activity within this area.

Pronghorn (*Antilocapra americana*) and mule deer are often found in the high elevation meadows and forest edges in the Mount Baldy vicinity, Arizona. However, any potential impact to Arizona willow is considered negligible due to low numbers. Although pronghorn occur within the East Fork of the Sevier area, Utah, they have not been observed within potential Arizona willow habitat. Observations of antelope have been made approximately 18 miles down the drainage (north).

Herbivory by rodents, especially voles (*Microtus* spp.), was reported by Medina (*in litt.* 1993) in Arizona as a source of predation in many Arizona willow stands, primarily affecting prostrate plants. These rodents ate roots and basal plant parts resulting in the loss or girdling of stems. Also, roots were often clipped in the construction of tunnel networks (Medina *in litt.* 1989). Rodent activity affecting Arizona willow was primarily in the wet meadows and occurred during the winter (Medina *in litt.* 1992).

Beaver (*Castor canadensis*) will always be a potential threat to most Arizona willow populations (Granfelt *in litt.* 1991). Beaver dam construction results in flooding of riparian areas. It also affects stream hydrology by creating new channels, streambenches, and deposition areas (Galeano-Popp 1988). Beaver activities, including site abandonment, can effect the local distribution of Arizona willow in several ways (Galeano-Popp 1988). Flooding can inundate and kill willow plants but may also contribute to the development of potential habitat for Arizona willow propagation (Granfelt *in litt.* 1992) and the expansion of habitat along the periphery of ponds (Galeano-Popp 1988). Abandonment of ponds again alters the hydrology of the site, causing local soil drainage and lowering of the water table.

Beaver activity has been recorded at numerous sites in Arizona willow habitat on both the Apache-Sitgreaves NFs and Reservation (Granfelt 1989a and *in litt.* 1992). At Skeeter Cienega along Ord Creek on the Reservation, Arizona willow are found adjacent to the creek but also up to 30 m (100 feet) away, topographically much higher than usual. This may be the result of past beaver activities which have altered the drainage patterns in the cienega (Granfelt 1989a). In general, the larger and more vigorous the riparian community, the less severe the impacts on Arizona willow from beaver (Galeano-Popp 1988). Beaver may be an important component in the natural dynamics of these riparian systems.

In Utah, beaver activity has been observed on two of the 19 populations of Arizona willow on the Dixie NF, in the upper portion of the Rainbow Meadows and East Fork of the Sevier River. Herbivory threats from beaver are not a significant impact on Arizona willow for three primary reasons: 1) sufficient amounts of aspen occur adjacent to Arizona willow populations on both the Dixie and Fishlake NFs; 2) aspen is the preferred food by beaver and Arizona willow would not receive much, if any use until aspen stands are depleted; and 3) very few beaver currently exist in the drainage where known Arizona willow populations occur. Although dam construction could result in flooding of riparian areas reducing potential habitat for Arizona willow, observations made in Utah during 1994 indicate this is not a problem. Beaver activity in upper Rainbow Meadows has resulted in a net gain of Arizona willow habitat by holding water on steeper side slopes where seep/spring water that normally would run down slope was held in place, creating better habitat for the willow. These areas currently have very healthy, robust populations of Arizona willow. In the East Fork of the Sevier population, beaver dams would probably increase potential habitat for Arizona willow and allow for expansion of this population by helping to raise the water table.

Arizona willow herbivory by insects include caterpillars of the mourning cloak butterfly (*Nymphalys antiopa*), beetles (Coleoptera) and grasshoppers (Orthoptera) (Fairweather 1993, Medina *in litt.* 1993). Insects tend to occur most often on leaves of younger stems. Caterpillars have been observed at many Arizona willow sites, generally causing a light defoliation. In a few cases, defoliation by caterpillars was heavy enough to cause branch dieback (Subirge pers. comm. 1992, Fairweather 1993). Insect herbivory appears to have a localized affect on Arizona willow.

Impacts by insects to Arizona willow populations in Utah are poorly understood. However, insect galls were observed in Rainbow Meadows and Lowder Creek on the Dixie NF.

### C. Disease

In Arizona, a fungal disease infecting Arizona willow has been tentatively identified as the rust *Melampsora epitea* (Fairweather 1993). Rust species have a very complex life cycle, with multiple spore stages and often with alternate host species (Fairweather 1993). Some rusts have alternate host species in the gooseberry family (genus *Ribes*), but the alternate host for this rust remains unknown. Rust infections have been observed at a minimum of eleven sites; seven on the Reservation, four on the Forest (Granfelt *in litt.* 1995b).

Heavily infected plants have been found at three of the six infected sites (Fairweather 1993). *Melampsora* typically causes premature leafdrop, loss of plant vigor, and a reduction of stored carbohydrates which delays regrowth the following spring. Heavy rust infestations have caused stems to dieback and have delayed plant shoots entering dormancy making them susceptible to frost damage. Flower and seed production by infected Arizona willow is practically non-existent (Fairweather 1993).

Granfelt (in Galeano-Popp 1988) reported Arizona willow being defoliated along a 1 km (0.6 mile) stream reach on the Reservation, regardless of pre-infection plant size or apparent vigor. The damage from rust is evident in the persistent dead stems of previously large plants, with new shoots producing the majority of leaf growth. Though heavily infected Arizona willow have re-sprouted in following years, some plants have died (Granfelt 1990). The once vigorous and healthy Arizona willow population studied by Granfelt has experienced 20 percent mortality in the five years since the rust infestation began (Granfelt *in litt.* 1992). Mortality of Arizona willow plants may be a direct cause of the rust, or the rust infestation may have made the plants more susceptible to a secondary pathogen or an environmental stress, such as freezing, browsing, reduced stream flows through diversions, or siltation (Fairweather 1993).

Resistance to the rust varies among individual Arizona willow plants. Apparently healthy, uninfected plants are adjacent to heavily infected plants (Galeano-Popp 1988). The ability to

resist rust infections is genetically controlled, with infestations very host specific, to the point of being virulent to particular genotypes (Fairweather 1993). To maintain healthy Arizona willow populations within the context of the natural host/disease inter-relationship, a diverse Arizona willow gene pool is critical, with plants both resistant and non-resistant to a particular pathogen variety.

In Utah, no disease has been observed on Arizona willow plants. This could be attributed to the robust, healthy condition of populations on the Markagunt Plateau. Some plants in the Hancock Peak population that overhang the bank near the water surface have shown leaf damage. This is probably due to water damage resulting from high water flow causing rust-like spots on the leaf surface (Atwood pers. comm. 1994). Fairweather (pers. comm. 1994) examined leaves collected from the site and confirmed this damage as a non-rust or other disease. Some frost damage has occurred on some high elevation populations particularly at sites where the tops of plants are exposed to extreme cold during winter months (Atwood pers. comm. 1995).

#### D. Timber Harvest

Though habitat disturbance from livestock was considered by Galeano-Popp (1988) to have been a major source of siltation in Arizona willow habitat on the Apache-Sitgreaves NFs, there are other factors contributing to Arizona willow habitat degradation. Timber harvesting and its related activities such as skid trails and road construction, may result in excess runoff, increased erosion and sedimentation, and down cutting of stream channels. Most of the upper watersheds in Arizona on the Apache-Sitgreaves NFs containing Arizona willow habitat are within wilderness areas where timber harvest does not occur. However, limited timber harvests on the Forest have occurred in other areas within the range of Arizona willow. On the Reservation, timber harvests have occurred within all watersheds which have Arizona willow (Granfelt *in litt.* 1991). On the Reservation, the effects of streambed down-cutting due to logging done in conjunction with the establishment of ski slopes at Sunrise Ski Resort are evident along portions of Becker Creek (Granfelt *in litt.* 1991). Timber harvest on the Reservation adjacent to many Arizona willow habitat areas has been deferred through the remainder of this decade. There may be harvesting after the year 2000. However, the Tribe's Timber Management Plan states



that a 300-foot (100 yard) stream buffer zone is used where the threatened Apache trout (*Oncorhynchus apache*) occurs. This includes many of the Arizona willow populations.

In Utah, effects from timber harvesting have not been documented. Associated activities such as road and skid-trail construction has created increases of sediment transport into watersheds. Effects on increased waterflow from harvesting are currently being monitored by BYU research graduate students. In an attempt to mitigate the potential increases in overland flow, a 33 meter (100 foot) special management riparian buffer has been established. This buffer is being monitored and evaluated on each timber harvest project.

#### E. Recreation

Recreational pursuits such as hiking, horseback riding, hunting, and fishing along Arizona willow streams, have an additive impact on Arizona willow habitat. Galeano-Popp (1988) noted that impacts from heavy recreation use on the Apache-Sitgreaves NFs were localized (especially along portions of the West Fork of the Little Colorado River), but these impacts appeared to be significant. When the Forest became aware of some of these impacts in 1980, certain areas were closed to camping, and access to the stream was re-directed. However, streambank condition remains unfavorable for Arizona willow establishment as demonstrated by extremely low Arizona willow densities. Trails within the Mount Baldy Wilderness Area are currently being re-routed out of the riparian area. Stream crossings by trails used by horseback riders continue to cause localized impacts to riparian systems. On the Reservation, most of the high elevation areas around Mount Baldy are closed to non-Tribal members, and access to streams and lakes by fishermen is restricted to designated areas.

On the Reservation, Arizona willow plants have been lost and habitat quality reduced due to construction of the Sunrise Park Resort and associated ski runs, parking lot, roads, snow-making reservoir and pipeline, and other facilities. The former stand of Arizona willow found along tributaries of Becker Creek has now been markedly reduced through habitat modification, degradation, and loss (Granfelt 1989a). Stream channelization, erosion of upland areas, and siltation from roads and road construction has degraded Arizona willow habitat. Individual plants have been buried under debris from the parking area and road construction. Various plans

for expansion of the resort are being considered by the Tribe. Additional development may potentially increase the area and severity of impact to Arizona willow.

Similarly in Utah, it has been noted that on the East Fork of the Sevier population, Dixie NF, off-highway vehicle (OHV) users have impacted potential habitat. In addition, campsites have been long established in the riparian area and were still in use during 1994. These sites have been negatively impacted. In these areas, compacted soils, bank sloughing, and relatively poor plant composition is contributing to habitat degradation (Rodriguez *et al.* 1995).

## VI. REVIEW OF SPECIAL STATUS DESIGNATIONS AND PROTECTIONS

Federal government actions on Arizona willow began on December 15, 1980, when FWS published a Notice of Review for Native Plants in the Federal Register (45 FR 82480). That notice included *Salix arizonica* in category 1, which includes those taxa for which the FWS has sufficient information on biological vulnerability and threat(s) to support the appropriateness of proposing to list them as endangered or threatened under the authorities of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). This designation for Arizona willow was based on its status as a very localized endemic, small population size, and the threat of degradation of riparian habitat by livestock usage (Fletcher 1978).

A status report completed by Phillips *et al.* (1982) in Arizona recommended that Arizona willow be removed from consideration for listing as a threatened or endangered species. Phillips *et al.* (1982) found that Arizona willow had a limited distribution but was locally common, though never the dominant plant species. They reported that all populations appeared healthy with reproduction evident, though many plants were grazed and had a hedged appearance. Based on the recommendation by Phillips *et al.* (1982), the November 23, 1983, Supplement to Review of Plant Taxa for Listing (48 FR 53640), included *Salix arizonica* as a category 3C species. Category 3C includes those taxa that have proven to be more abundant or widespread than previously believed and/or those that are not subject to any identifiable threat. If further research or changes in land use indicate significant decline in any of these taxa, they may be reevaluated for possible inclusion in category 1 or 2.

The September 27, 1985, Federal Register notice (50 FR 39526) of plants under review for threatened or endangered classification, placed Arizona willow in category 2 due to further questions concerning vulnerability and threats to the small populations. Category 2 includes those taxa for which there is some evidence of vulnerability but for which there are not enough data to support a proposed rule for listing.

Arizona willow was again placed in category 1 in the February 21, 1990, revision of the Plant Notice of Review (55 FR 6184). Studies on the Apache-Sitgreaves NFs by Galeano-Popp (1988) provided additional information on vulnerability and threats faced by this species. Granfelt's (1989a) survey on the Reservation concluded that the Reservation population of Arizona willow is diverse and healthy. However, numerous threats to its fragile habitat was recognized (Granfelt 1989a).

A proposed rule to list Arizona willow as an endangered species in Arizona with critical habitat was published in the Federal Register on November 20, 1992 (57 FR 54747). Two public hearings were held regarding this proposal. On March 2, 1993, a public hearing was held in Eagar, Arizona, and on March 3, 1993, a public hearing was held in Whiteriver, Arizona. Notification of the public hearings and reopening of the comment period until April 2, 1993, was published in the Federal Register on February 12, 1993 (58 FR 8249). Newspaper notices of these hearings were published in the Arizona Republic, Phoenix, Arizona, on February 15, 1993, in the White Mountain Independent, St. Johns, Arizona, February 19, 1993, and in the Apache Scout, Whiteriver, Arizona, end of February, 1993. Comments provided as part of the public hearing and open comment period are part of the Arizona willow administrative record (U.S. Fish and Wildlife Service 1995).

On May 31, 1994, the Southwest Center for Biological Diversity filed a Summons and Complaint based on the FWS's failure to meet statutory deadlines to take final action on the proposed rule to list Arizona willow. The FWS, in negotiation with the plaintiffs, reached an agreement to take final action on the proposed rule by April 30, 1995. Based on the reductions of threats and management commitments provided through this Conservation Agreement and Strategy, the FWS has determined that listing is no longer warranted and published a withdrawal of the proposed rule in the Federal Register on April 28, 1995 (60 FR 20951) (Appendix G).

Arizona willow is protected by the Arizona Native Plant Law (Arizona Revised Statutes chapter 7, title 3, article 1) as a Highly Safeguarded Species. This law prohibits the collection of this species unless a permit for educational or scientific purposes is granted by the Arizona Department of Agriculture. However, overuse from collecting is not presently considered a threat to Arizona willow and these permit requirements do not protect populations from habitat degradation or loss. This State law does not apply to Tribal lands.

Several Federal laws, executive orders, and policies indirectly provide varying degrees of protection for Arizona willow habitat. The National Environmental Policy Act of 1969 requires Federal agencies to prepare environmental compliance documents for Federal actions, which would include consideration of the effects of proposed actions on special status species, including Arizona willow. Section 404 of the Federal Water Pollution Control Act of 1948 (Clean Water Act), as amended, Federal Executive Orders 11988 (Floodplain Management) and 11990 (Protection of Wetlands), and State of Arizona Executive Order 89-16 (Streams and Riparian Resources) also provide protection of Arizona willow habitat under certain conditions. The Corps of Engineers has stated that many stream reaches providing Arizona willow habitat are under the jurisdiction of section 404 permitting of the Clean Water Act (Souder 1993). However, each of these regulatory mechanisms have certain exemptions and exceptions which will preclude the protection of Arizona willow and its habitat from a variety of project actions.

The National Forest Management Act of 1976 and its implementing regulations require the FS to manage national forest to provide enough habitat to maintain viable populations of native species, such as Arizona willow. These regulations define a viable population as one which "has the estimated numbers and distribution of reproductive individuals to insure its continued existence." The Regional Forester of the Southwestern Region (Albuquerque, New Mexico) maintains a list of plant species on national forest lands which are considered to be sensitive. Arizona willow is included on this list. The Regional Forester of the Intermountain Region (Ogden, Utah) is currently reviewing a proposal for the designation of Arizona willow as a sensitive species. This process should be completed by April 1995. By policy, the Forests must evaluate any proposed action for possible negative effects to sensitive species. FS policy also requires a permit to collect sensitive species, including Arizona willow on the Forest (USDA Forest Service, Forest Service Manual, Title 2800, *in litt.* 1986).

Previously, a cooperative agreement and Memorandum of Understanding (Agreement # 14-16-0002-91-219, and MOU # MU-RM-91-138) for the management of Arizona willow was entered with the Apache-Sitgreaves NFs, FS Rocky Mountain Forest and Range Experimental Station, Fish and Wildlife Service, and Arizona Game and Fish Department. The agreement was signed April 12, 1991 and called for certain conservation planning actions. The agreement specified objectives to define long-term recovery goals, describe recovery actions, identify information and research needs, and to develop management and monitoring plans for the species in fiscal year 1991. This agreement expired in 1994.

The Tribe, as a sovereign entity, has adopted numerous codes, regulations, procedures, and policies that govern activities on the Fort Apache Indian Reservation. These laws and regulations govern land management, livestock grazing, health and safety, timber harvest, road construction, collection of biological materials, wildlife management, and recreation use. Many of these provisions serve to protect Arizona willow and its habitat. The Tribe has designated all streams as well as adjacent riparian zones as "sensitive fish and wildlife areas." In addition, the Tribe has restricted activities in high elevation riparian areas. The Tribal range and forage management plans contains explicit provisions to protect sensitive riparian areas. The Tribe has closed many areas of the Reservation to most activities. The Tribal Game and Fish Code explicitly prohibits the taking and disturbance of plants without a valid Tribal permit. Violation of these laws may give rise not only to Tribal but also to federal prosecution. Scientific collections on the Reservation are also regulated and applications for collection permits must be submitted to the Tribal Chairman and be approved by the Tribal Council.

The Arizona willow is recognized by the State Heritage Programs in Utah and Arizona as a globally ranked "G2" (G=global) species. Species' "G" ranks are coordinated through The Nature Conservancy National Office and the various State Heritage Programs. The G2 ranking is based on the low number of populations and the vulnerability of many of the known sites. Utah and Arizona Heritage Programs, within the Utah Division of Wildlife Resources and AGFD respectively, rank Arizona willow as an "S2" (S=State) species. An S2 state ranking is based on the limited number of populations within each state.